

Unmanned Aircraft: A Pilot's Perspective

"It's not un-piloted..."



Mark Pestana
NASA Research Pilot
Dryden Flight Research Center,
Edwards AFB, CA

**Presented to the
16th Annual Symposium on
Aviation Psychology
Dayton, OH, May 2011**

Note: The information in this presentation is the author's and may not reflect official NASA policy

TOPICS

- **NASA MQ-9 *Ikhana* (Predator-B)**
- **Pilot – Vehicle Interface Design**
- **Defining “Pilot” in the UAS world**

NASA MQ-9 *Ikhana*

Ikhana = Native American Choctaw word for...

“Intelligence”

“Learning”

“Awareness”



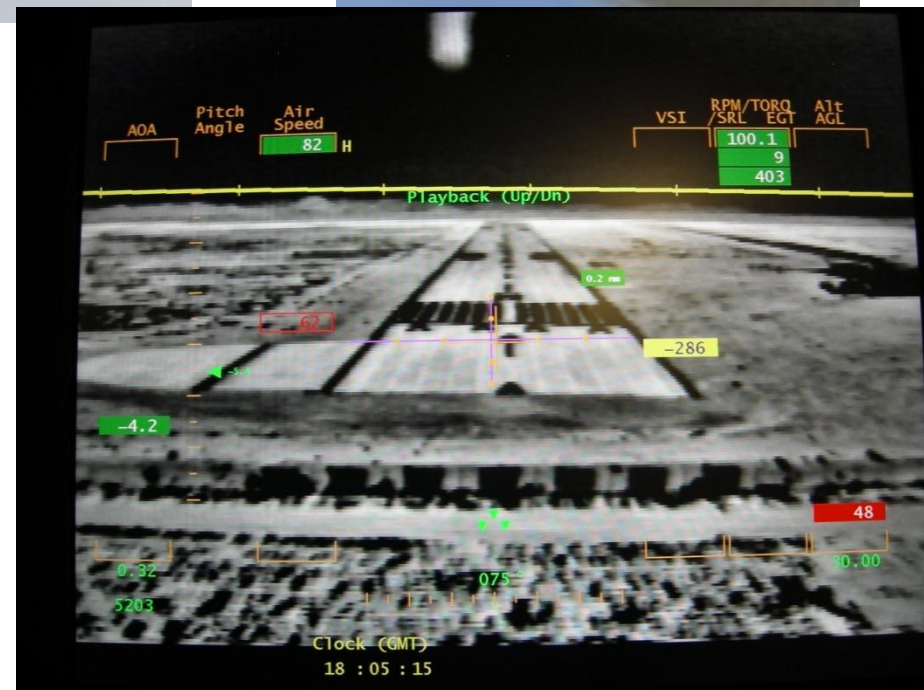
MQ-9 Reaper/ Predator-B



MQ-1 Predator -A



Two nose-mounted cameras: Color Visible & B&W Infrared



Initial power-up,
fueling, engine start,
and local area flying

**C-Band
Line-of-sight antennas
and remote camera**



Ground Control Station

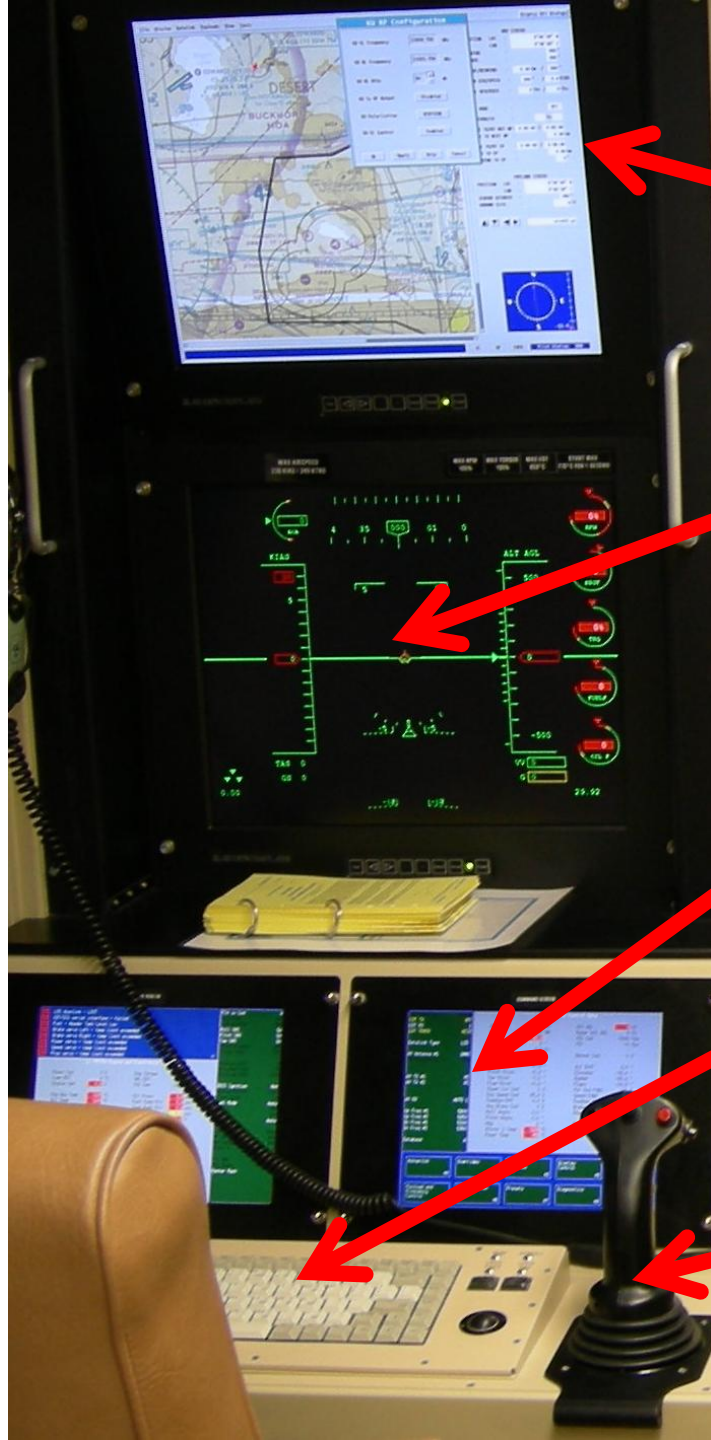
Over The Horizon
Long Range Link
Ku-bandSatCom



MQ-9 Ground Control Station (GCS)

Two Pilot Stations





**Tracker Display
Systems Menus**

Camera View with HUD

**Systems Displays
Systems Menus**

Keyboard / Trackball

**Control Stick,
Throttle, Flaps, Rudder Pedals**



Remote Camera

Provides situational awareness of people , equipment, and vehicle movement near aircraft.





Ground Control Station:
People talk
Phones ring
People come and go

Long-duration missions.
Multiple crews: Hand-overs



Fatigue
Boredom
Complacency
Shift work = “day sleepers”



So, what's it like to fly a UAS?

Well....What if you stepped into your cockpit...

...and you lost 4 of your 5 senses?

You only have *vision*!



Only 1 sense?

- You **can't hear** the engine rpm fluctuating
- You **can't feel** vibrations, accelerations or motion
- You **can't smell** the fuel leak
- You **can't taste** the electrical fire smoke
- AND, you **lose vision** in one eye, 30° FOV!
- WELCOME to UAS flying!

With decades of evolving cockpit design, today's aircraft exhibit common standard control and display formats and arrangements.

Example: The “T” arrangement
It works in many types, small and large.



Cessna 182



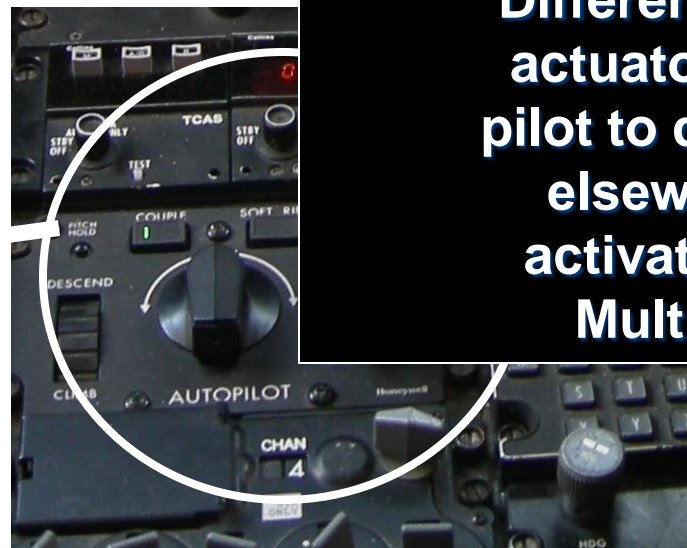
Boeing 737



**Use of the
Tactile sense**



**Different shapes of
actuators enable the
pilot to direct attention
elsewhere...while
activating systems.
Multi-tasking**



Digital Information Can be displayed in Analog Format



**Unmanned Aircraft System
Digital /Tabular Display Format**

Example of Display and Control Issues

IFF Transponder “IDENT” Task

1. Remove right from control stick
2. Move cursor to tracker display
3. Click on TOOLS menu
4. Scroll to IFF
5. Click to open IFF window
6. Click “IDENT” button
7. Click “APPLY”

Accessed by trackball
and Left/Right buttons

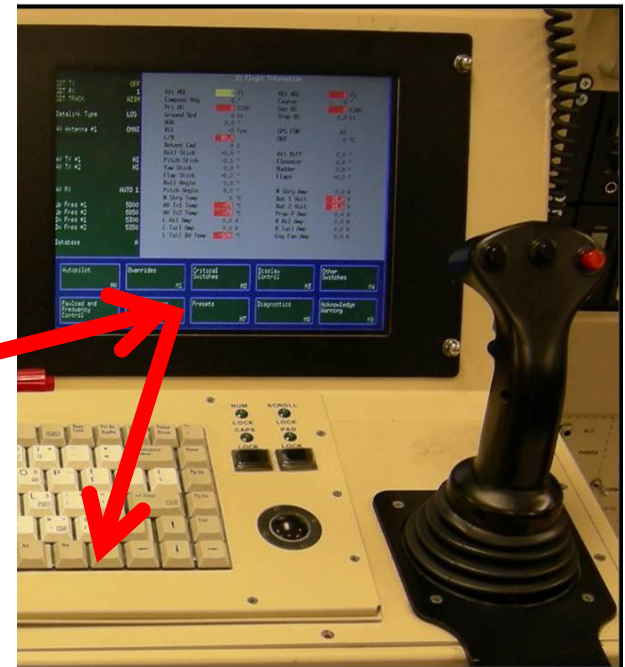


Example of control / display issues

Q: How do I TURN **ON**
the Fuel Heaters?

Fuel Heat Inhibit

Disable / Enable



“How far can you see a plane?”

Light
Contrast
Color
Texture
Distance
Motion
Shape
Reflectivity
Atmospheric Filtering
Weather
Acuity



Q: What's a "pilot"?



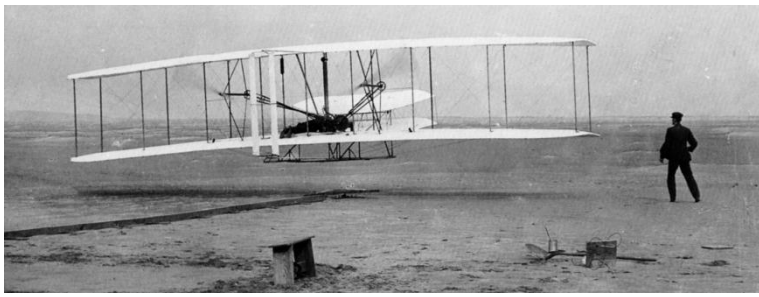


Samuel Clemens and his Pilot's Certificate

19th Century Pilot.

- Riverboat Captain
- Skills: River navigation, rudder control, soundings, shovel coal, supervisor...





20th Century Pilot

- Strapped to an airplane, direct interface to controls.
- Motor skills are primary metric of performance
- Increasing use of automation, systems management.





21st century pilot... "fly-by-wire"

- "Remotely" connected to the controls, systems management, monitor autonomous operations.
- **In some cases, motor skills have little/no relevance.**

Global Hawk cockpit:
Autonomous operations.
Mouse and keyboard controls.



What is a “pilot” ?

Knowledge, Ability, and Skill Sets

(relative relationships are not necessarily to scale)



Video Gamer

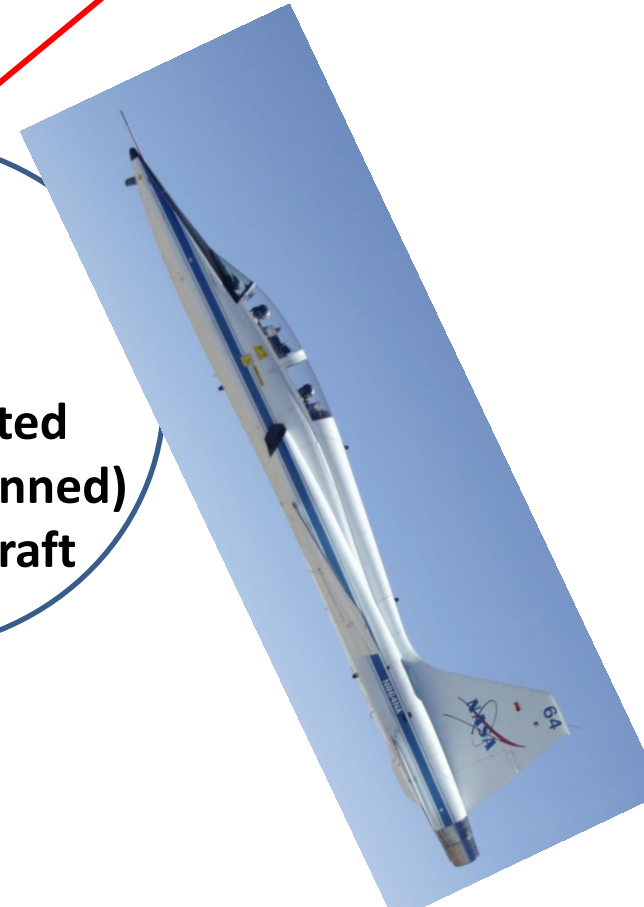


Radio Controlled
Visual Line-of-sight

What do these people
have in common?

Remotely
Piloted
Unmanned
Aircraft
System

Piloted
(manned)
Aircraft



What is a “pilot” ?

Knowledge, Ability, and Skill Sets

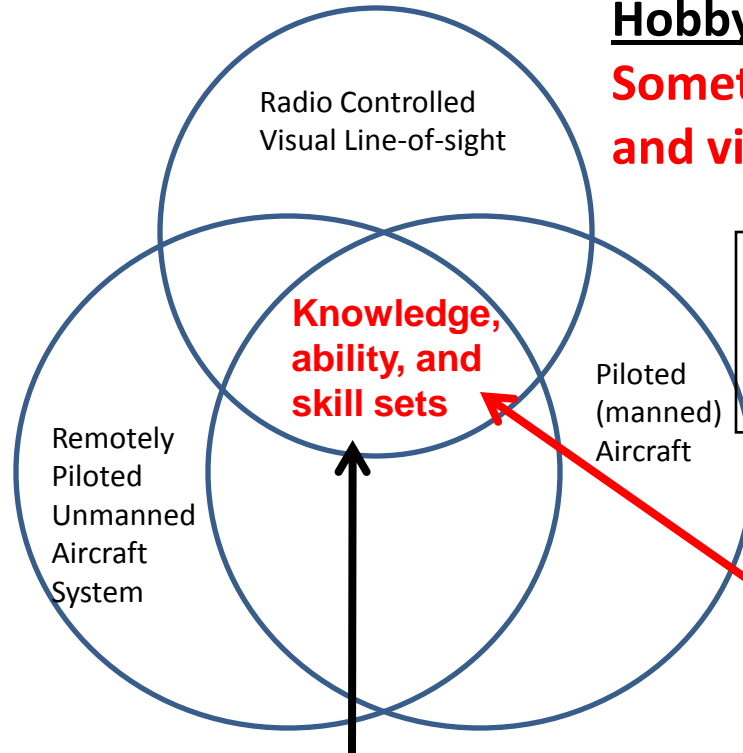
(relative relationships are not necessarily to scale)

Video Gamer
Reset Button

Model airplane
Hobbyist

**Sometimes...left is right,
and vice versa.**

UAV Pilot
**Skill sets depend on
control method**



Jet Jock
**Self-preservation
instincts.**

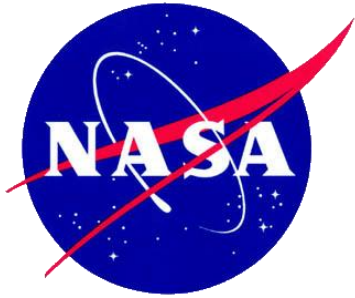
**Plus: Judgment,
experience,
flexibility, etc.**

Airmanship / Air Sense / Knowledge: Navigation; Communication protocols; FAA Airspace Rules, Requirements, and Regulations; Terminal area procedures, Weather forecasting and alternate airfield assessment, Mission planning, Emergency procedures, aircraft systems, principles of flight, etc.

Considerations

- Proven human-machine interface standards exist
 - use them / adapt to UAS as required.
- Extended duration missions and remote operations require new con-ops for multiple crews, circadian shift, etc.
- No single definition of “Pilot”
 - Hence: Training, qualification, currency, proficiency standards depend on the method of control, et al.
- Consider a future state, where multiple UAS are controlled by a single “operator”.
 - May blend the roles of pilot and air traffic controller.

Western States Fire Mission





Where is the exact location of fire lines and hot spots?



Where do you employ limited resources?
...and keep them Safe!



FAA Provisions...The COA

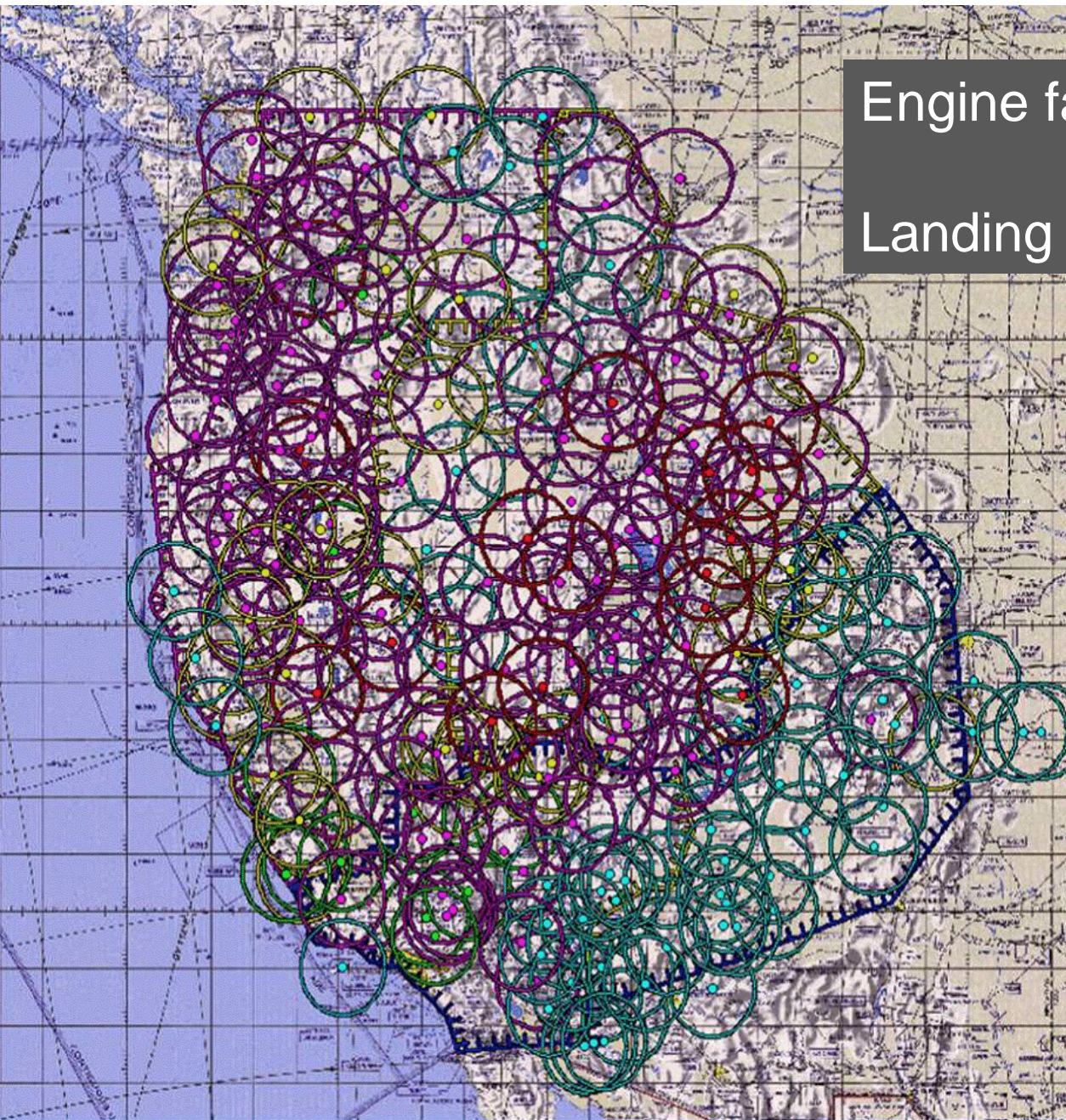
- **One assigned Flight Level (FL 230), in Class A airspace.**
- **-Two-way radio communication and transponder.**
- **- Climbs/descents while in Edwards AFB airspace.**
- **File flight plan 72 hrs prior, fly 1 of 3 “standardized” routes.**
- **Demonstrated “Lost Link” ability: Return via same route.**
- **Emergency landing sites: Military only.**
- **Designate “set-down sites” (fields, lakebeds) if engine failed.**
- **MQ-9 demonstrated reliability/capability/systems redundancy**

Approved landing sites for
a generator failure and
range limited by battery
life.



Engine failure glide range

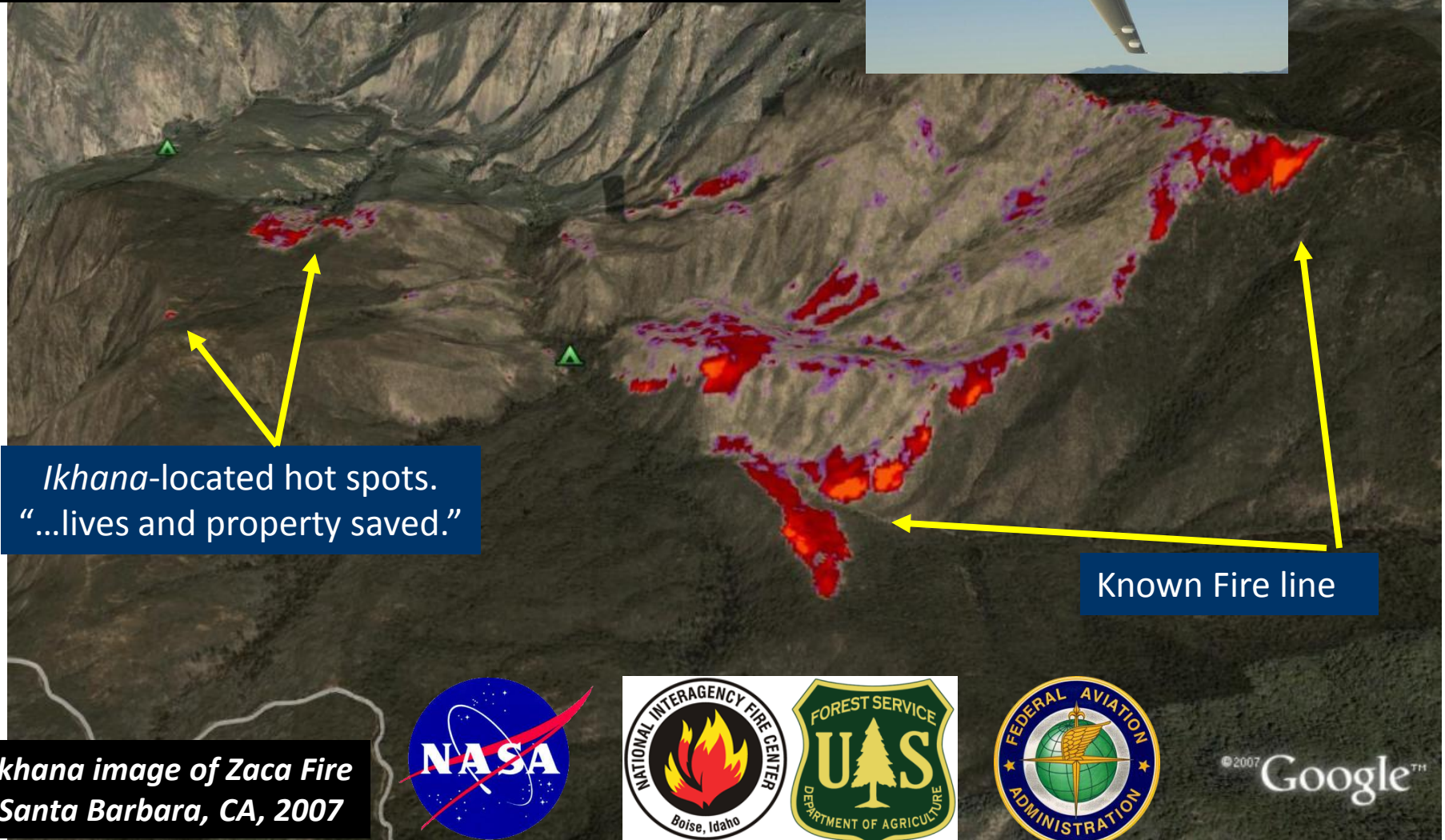
Landing sites



Four Tech Demonstration Missions



Ikhana Infrared Data and GPS locations are merged with 3-D Google Earth map/image. Transmitted to Fire Fighters in less than 10 minutes (vs. hours).



Ikhana-located hot spots.
"...lives and property saved."

Known Fire line

Ikhana image of Zaca Fire
Santa Barbara, CA, 2007



© 2007 Google™

Questions?

